Minutes of the meeting and partial answers – MuCool review of detail design – 10/17/02

Presents: Jay Theilacker, Dave Richardson, Barry Norris (by hone), Paula Lambertz, Arkadiy Klebaner, Christine Darve

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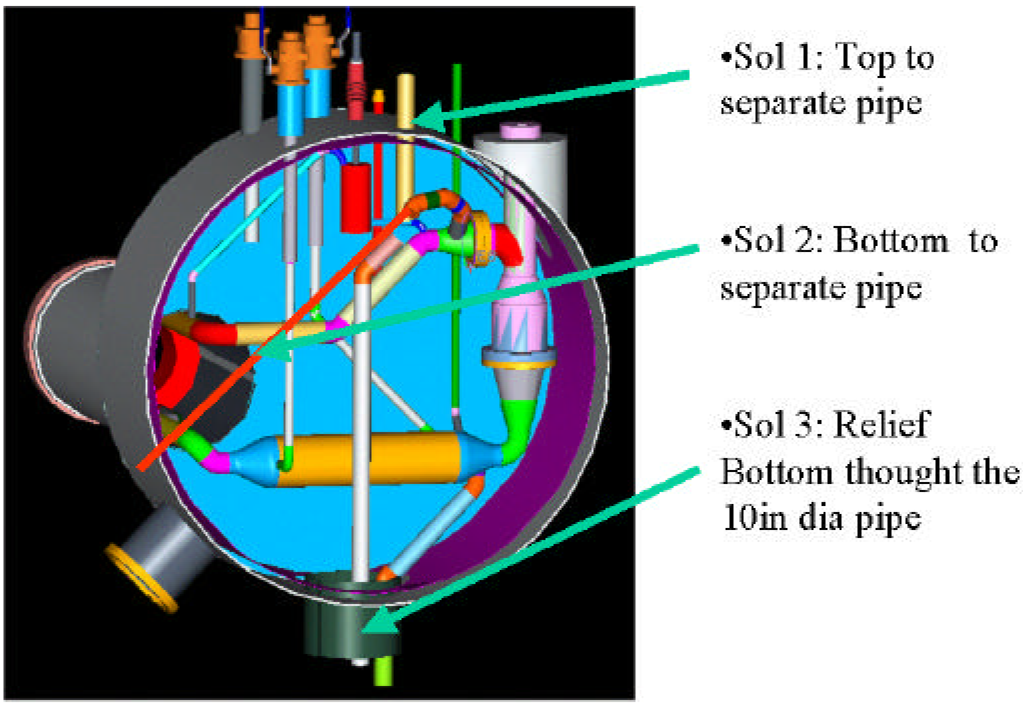
The goal of the meeting was to discuss various technical solutions for the design of the MuCool experiment cryostat. For reference: Information on the project, 3D Model and conceptual drawings are available at http://www-bdnew.fnal.gov/cryo-darve/mu_cool/mu_cool_HP.htm
This minute is composed on a sequence of question/ answers.

A Hydrogen Relief Lines

Proposed solutions:



Decision: We chose the solution 1, if enough space is available on the top of the cryostat. This solution will be composed of a Long 1.5 " IPS bended line (radius r), exiting by the top of the cryostat. AGCO valves will be installed on the LH2 relief line, outside the cryostat and easily accessible.

1 . minimum bend radius of piping for optimal pressure drop?

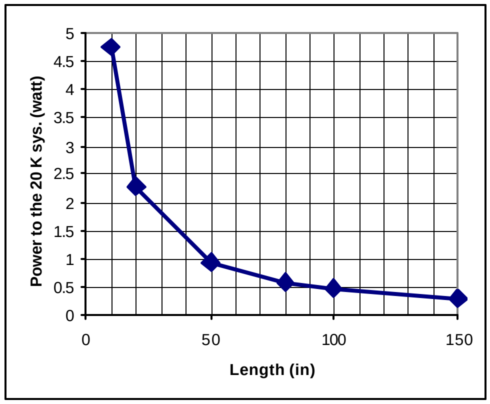
Answer: The minimum allowable bending radius, r, was calculated in order to accommodate the min pressure drop to the relief system. For the 1.5" IPS r > 6" in .

2 . cold check valves required?

Answer: Have to check with potential thermo acoustic oscillations. SLAC (E158 experiment) did use check valves located on their valve panel (see E158 Process and Instrumentation Diagram). I let a message to Bob Carr from Caltech.

3 . min vertical length of pipe to 300K?

Answer: Another concern for the LH2 relief line is the length of the pipe inside the cryostat. This pipe should be long enough to limit the heat load by conduction from the ambient to the 17 K system but short enough to limit the pressure drop. The following curve presents results of the heat load to the 17 K system from the ambient for a 1.5"IPS Sch10.



➔The length of the relieving pipe inside the cryostat should be of the order of 50 in

B <u>Heat Exchanger</u>

4 . what do the heaters look like?

Answer:

<u>Solution 1:</u> See specification for the bracket type provided by Ch to Paula. Two bracket heaters would be installed in the insulation vacuum wrapped around the HX. Concerns: The heat transfer though the wall needs to be studied. Christine will contact Cern who studied the influence of SS wall for heat transfer. But….. this solution can only to built with no purge system around the heater. This implies that we will have to convince the safety panel that the system is intrinsiquely safe because under vacuum condition the ignition of the H2 is reduced to ~ zero. Interlocks would be mandatory and controlled by the insulation vacuum pressure. If we adopt this solution, Jay proposed that we performed a test to measurement the heat transfer from the heater to a SS pipe filled with water. The fastener could also be optimized.

<u>Solution 2:</u> Like for E158 experiment at SLAC, 0.19 W/ft Nichrome wire can be wrapped around composite rod and immersed in the LH2. More information will be provided from E158 (Contact by Christine to Bob Carr or John Weisend).

5 . how are they fastened?

Answer: M-bond could be used for the bracket type.

The wire would need a ceramseal connector rated for cryogenic temperature: 10236-03-CF (see E158)

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C General Piping

6 . what about thermal contraction?
Answer: Thermal contraction will be absorbed by supporting system and "L" shape of the piping assembly. If really needed: Bellows could be use for alignment purpose and may be considered for stress reduction due to thermal contraction.
The length of the SS pipes, in a unique direction, are less then 0.7 meter implying a thermal contraction less than 1.6 mm….

The cryostat is composed of 1) magnet cryostat: part of the cryostat located inside the magnet bore, 2) outside cryostat: parts housed in the 48 in diameter vacuum vessel located outside the magnet bore. Both parts are welded each other.

- For the magnet cryostat, thermal contractions of the SS pipes will be absorbed by the supporting system. The LH2 absorber support fixes the LH2 absorber to the thermal shield and to the vacuum vessel. Hence providing a fixed point. The other supporting systems will allow the pipes to move in the longitudinal direction due to thermal contraction. And a clearance in the assembly will permit us to relieve the radial stress. Isostatic scheme:

LH2 absorber supports (fixed) Other supports (adjustable)

- For the outside cryostat: pipes will be anchored to G10 bars. These three bars are composed of G10 rods assembled to stainless steel pads, which are welded to the inner diameter of the vacuum vessel. These rods will hold the pipes into positions via brackets. See proposed solution by Christine. Any other solutions are welcome…
The "L" shape of the pipes assembly will take the displacements due to thermal contraction. Christine will supply more calculations and locations of the rods will be discussed.

6 where are the piping anchor points?
Answer :See conceptual drawing for the supporting system in the magnet cryostat. Christine will provide drawing for the outside cryostat supporting system.

7 do we need internal supports?
Answer: We need internal support in the magnet cryostat and in the outside cryostat. See 5.

9 . is there a scenario where we need to worry about thermal expansion (this was not brought up in meeting)
Answer: No

D Vacuum Vessel

10 . is support stand fixed or adjustable?
Answer: See 5.

11 . Is cryostat physically attached to magnet?

12 . use to fastened the cryostat to the ground and to the magnet.

Answer: The cryostat slides in the magnet bore w/o permanent fixation. A common supporting system between the magnet and the cryostat will permit us to achieve the assembly needed to support the weight and absorber the forces developed during quench.

13. how do we stiffen the flat plates? (thickness, internal bracing, external bracing?)

Answer: As proposed by Jay, the two opposite flat plates of the outside cryostat should be fastened (welded) to reduce the vacuum forces. Christine will provide the calculation of the forces applied to the plate and the thickness of this plate.

E Instrumentation

12 . how much? 13 . where? 14 . what type?

Answer :

See http://www-bdnew.fnal.gov/cryo-darve/mu_cool/linac/instrumentation/list_instrum.xls for our instrumentation. More details about the signals located inside the LH2 absorber will be given by the experimenters…

Additional information:

⇒ The weight of the vacuum vessel is estimated to 500 lbs. Need to be estimated more precisely by Paula.

⇒ Vibrations are not an important issue for the test (personal communication btw Bob Carr and Christine).

⇒ Thermalisation of the Aluminum shield: Successful tests were performed at MW9 on the welding of Al sheet to Al tube.
Ch showed results of thermal resistance studies for various configurations of braids or strips (Cu, Al, SS) used for cryostat models at Cern; including the solution applied for the initial Cryostat Thermal Model. Other design of the LHC IRQ HXTU permitted us to see that only brackets installed every 16in apart from each others on a SS pipe, can thermalize an Al shield (similar set-up: only radiation from 300K) down to 90 K..

F Last but not least …

Thanks again for all your fruitful ideas on how to optimize the design of the MuCool. We summarized and covered aspects that were maybe not so clear. Communication is a key issue, daily questions and answers are encouraged. In addition, issues will be weekly summarized after IMDP Tuesday meeting, where Paula, Dave, (Barry) and Christine will meet. Jay and Arkadiy are welcome to attend and will certainly be asked to validate and develop the proposed solutions. Solutions should be as close as what the cryogenic department is used to design.

Christine will provided:

⇒ calculations of the vacuum force on the cryostat flat plate,
⇒ calculations of thermal expansions,
⇒ scheme of the supporting system principle
⇒ answer from E158 about thermo acoustic oscillation and check valve.
⇒ Get info on heat transfer with various thickness of SS
⇒ Signal distribution from experimenters

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